SUB C1 Cont

B9 Cont

an insulating film deposited on the barrier film and having a surface electrical resistance kept in a range from 1.0 x 10^6 Ω/□ to 1.0 x 10^{16} Ω/□ even after heating process at 550 °C for 1 hour; and

an electrode film for forming a display panel deposited on the insulating film so that diffusion of metal ions of the electrode film into the glass substrate is substantially prevented by the barrier film and insulating film.

Please add new claims 9 ~~and~~ 10, as follows:

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~~9. A glass article as claimed in claim 1, wherein said barrier film consists mainly of said indium oxide or tin oxide.~~

10. A glass substrate as claimed in claim 8, wherein said barrier film consists mainly of said indium oxide or tin oxide.

IN THE ABSTRACT

Please change the abstract, as attached herewith.

REMARKS

The specification has been reviewed, and clerical errors of the specification have been amended.

On page 3 of the Action, claims 6-8 were rejected under 35 U.S.C. 112, first paragraph. In view of the rejection, claims 6 and 8 have been amended. In this respect, as stated on page 1 of the specification, the invention relates to a glass article and a glass substrate for a display panel. The display panel may be a plasma display panel, a field emission display and so on, known already in the art. In the display panel, it is common to have electrodes or electrode films. In claims 6 and 8, the electrode film is used as an electrode for the display panel. Please withdraw the rejection for claims 6-8.

In paragraph 5 of the Action, claim 1-5 were rejected under 35 U.S.C. 102(b) as being anticipated by Tsai et al. In paragraph 7 of the Action, claims 6-8 were rejected under 35 U.S.C. 103(a) as being unpatentable over Tsai et al in view of Ueoka et al. In paragraph 8 of the Action, claims 6-8 were rejected under 35 U.S.C. 103(a) as

being unpatentable over Tsai et al in view of Ota.

In view of the rejections, claims 1, 4-6 and 8 have been amended. Also, new claims 9 and 10 have been added.

As clearly recited in amended claim 1, a glass article of claim 1 comprises an alkali-containing glass substrate, and a barrier film mainly formed of at least one of indium oxide and tin oxide. The barrier film is formed on a substantially entire outer surface of the alkali-containing glass substrate without operating as an electrode, so that in case metal is deposited on the barrier film, diffusion of metal ions of the metal into the glass substrate is substantially prevented.

Namely, the barrier film used in the glass article of claim 1 is different from the electrode to be formed on the glass substrate when used as the display panel. Therefore, the barrier film is formed on the entire outer surface of the glass substrate. The barrier film of the invention prevents diffusion of metal ions into the glass substrate when metal or electrode is deposited on the barrier film.

In Tsai et al. cited in the Action, a liquid crystal display device includes a glass substrate 12a, a TiO_2-SiO_2 composite undercoat 13a, a transparent conductive ITO layer 14a, and a TiO_2-SiO_2 composite overcoat 14a. The ITO layer 14a is used as an electrode for the liquid crystal display.

In claim 1 of the invention, the barrier film deposited on the glass substrate is mainly formed of at least one of indium oxide and tin oxide. In Tsai et al., the undercoat 13a deposited on the glass substrate 12 is the TiO_2-SiO_2 composite layer, which is entirely different from the indium oxide and tin oxide used in claim 1 of the invention.

In claim 1, the barrier film is formed on a substantially entire outer surface of the alkali-containing glass substrate without operating as an electrode. In Tsai et al., the ITO layer 14 is deposited on the substrate through the TiO_2-SiO_2 composite undercoat 13a. Since ITO layer 14 is used as the electrode in Tsai et al., the ITO layer does not constitute the barrier film of the invention.

In claim 1, further, in case metal is deposited on the barrier film, diffusion of metal ions of the metal into the glass substrate

is substantially prevented by the barrier film. In Tsai et al., the diffusion of the metal ions are not disclosed. The TiO_2-SiO_2 composite layer is used such that the out diffusion of impurities (sodium ions) can be prevented from soda lime glass into liquid crystal to destroy the property of the liquid crystal.

Therefore, Tsai et al. does not disclose or even suggest the features of claim 1 of the invention.

In claim 8, a glass substrate for a display comprises an alkali-containing glass substrate; an under layer for preventing diffusion of alkali ions formed on a surface of the alkali-containing glass substrate; a barrier film mainly formed of at least one of indium oxide and tin oxide, and deposited on a substantially entire outer surface of the under layer; an insulating film deposited on the barrier film and having a surface electrical resistance kept in a range from 1.0×10^6 Ω/□ to 1.0×10^{16} Ω/□ even after heating process at 550 °C for 1 hour; and an electrode film for forming a display panel deposited on the insulating film. The diffusion of metal ions of the electrode film into the glass substrate is substantially prevented by the barrier film and insulating film.

As explained before relative to claim 1, the barrier film formed of at least one of indium oxide and tin oxide is not disclosed or suggested in Tsai et al. Tsai et al. only discloses the under layer used in claim 8 of the invention. Since the barrier film is not disclosed in Tsai et al., the features in claim 8 are not disclosed or suggested in Tsai et al.

In Ueoka et al., as stated in the Action, silver is provided on a transparent electrode to form a bus electrode. Therefore, the electrode film of the glass substrate of the invention is disclosed in Ueoka et al. However, the barrier film used in the present invention is not disclosed or suggested in Ueoka et al.

In Ota, a low resistive material is layered on a transparent conductive film in a plasma display, and the low resistive material is specified as bus electrode. Although the electrode film used in the invention is disclosed in Ota, the barrier film used in the present invention is not disclosed or suggested in Ota.

As explained above, the cited references do not disclose or

suggest the barrier film used in the present invention. Even if the cited references are combined, the claims of the present application are not obvious from the cited references.

Reconsideration and allowance are earnestly solicited.

Respectfully submitted,

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1.(amended) A glass article comprising an alkali-containing glass substrate, and a barrier film mainly formed of at least one of indium oxide and tin oxide, said barrier film being [for preventing diffusion of metal ions] formed on a substantially entire outer surface of said alkali-containing glass substrate[, wherein said barrier film mainly consisting of indium oxide and/or tin oxide] without operating as an electrode so that in case metal is deposited on the barrier film, diffusion of metal ions of the metal into the glass substrate is substantially prevented.

4.(amended) A glass article as claimed in claim 3, wherein [the] a surface electrical resistance of said insulating film is in a range from 1.0×10^{6} Ω/□ to 1.0×10^{16} Ω/□.

5.(twice amended) A glass article as claimed in claim 3, wherein [the] a surface electrical resistance of said insulating film is kept in the range from 1.0×10^{6} Ω/□ to 1.0×10^{16} Ω/□ even after heating process at 550 °C for 1 hour.

6.(twice amended) A glass article as claimed in claim 3, further comprising an electrode film formed on said insulating film for forming a display panel.

8.(amended) A glass substrate for a display comprising: an alkali-containing glass substrate; an under layer for preventing diffusion of alkali ions formed on a surface of said alkali-containing glass substrate; a barrier film [for preventing diffusion of metal ions] mainly [consisting] formed of at least one of indium oxide [and/or] and tin oxide, and deposited on a substantially entire outer surface of the under layer; an insulating film deposited on the barrier film and having a surface electrical resistance kept in a range from 1.0×10^{6} Ω/□ to 1.0×10^{16} Ω/□ even after heating process at 550 °C for 1 hour; and an electrode film for forming a display panel deposited on the insulating film so that diffusion of metal ions of the electrode film into the glass substrate is substantially prevented by the barrier film and insulating film[,

said films being formed in the enumerated order, and

the surface electrical resistance of said insulating film being kept in a range from 1.0×10^{6} Ω/□ to 1.0×10^{16} Ω/□ even after heating process at 550 °C for 1 hour].

In a glass substrate for a PDP, a soda lime silicate glass substrate formed in a plate shape having a thickness of 1.5 mm - 3.5 mm or an alkali-containing glass plate with high strain point is used. Such glass substrate is produced by using a float process that is suitable for mass production and for obtaining an excellent flatness of the surface. During the process, float glass is exposed to hydrogen gas atmosphere, so that a reduction layer of a several microns thickness is formed on a surface thereof. It is generally known that such a reduction layer contains Sn^{2+} derived from melted Sn.

In the manufacturing process of the PDP, the application of Ag as a bus electrode onto a surface of a glass substrate via transparent electrodes is followed by heating to a temperature from 550 °C to 600 °C for 20 - 60 minutes, and the process is repeated for several times.

In this heating process, Ag^+ ions are diffused into the transparent electrodes and reach the glass surface where ion exchange between Ag^+ ions and Na^+ ions contained in the glass takes place. As a result of this, Ag^+ ions migrate into the glass and the migrated Ag^+ ions are reducted by Sn^{2+} existing in the reduction layer whereby colloids of Ag are formed. Due to the Ag colloids, the glass substrate is stained yellow.

Such problem of stain due to metal colloids may occur be occurred not

only in case of forming Ag metal electrode film, but also in case of forming another electrode film of ~~a~~ metal such as Cu or Au which diffuses easily. The problem of the stain due to the Ag colloids may occur also in a rear window glass of an automobile having striped Ag electrodes for defogging.

It has been proposed that, in case of using alkali-containing glass as a substrate for a display, a barrier film is formed to prevent metal ions to diffuse whereby preventing ion exchange between alkali in the glass and Ag or the like used as electrodes in case of PDP and thus preventing the stain of the glass due to Ag colloids, wherein the barrier film is made of ~~a~~ metal, a nitride, or an oxide such as SiO_2, ZrO_2, Al_2O_3, and TiO_2 (Japanese patent H09-245652A, Japanese patent H10-114549A, Japanese patent H10-302648A, Japanese patent H11-109888A, and Japanese patent H11-130471A).

However, the barrier film can not offer sufficient efficiency of preventing the diffusion of metal ions. In particular, the barrier film of the nitride is oxidized in a heating process in a PDP manufacturing process, thus reducing the efficiency of preventing the diffusion of metal ions.

OBJECT AND SUMMARY OF THE INVENTION

It is the object of the present invention to solve the aforementioned problems and to provide a glass article having no problem of stain due to metal colloids because of its excellent efficiency of preventing the diffusion of metal ions, and to provide a glass substrate for a high-quality display comprising the aforementioned glass article.

The glass article of the present invention has an alkali-containing glass substrate, and a barrier film formed on a surface of the alkali-containing glass substrate for preventing diffusion of metal ions ~~diffuse~~. The barrier film mainly consists of indium oxide and/or tin oxide.

The barrier film mainly consisting of indium oxide (In_2O_3) and/or tin oxide (SnO_2) has excellent efficiency of preventing diffusion of metal ions and thus can effectively prevent elution of alkali contained in glass and prevent diffusion of metal ions contained in a metal film formed on the surface of the glass plate into the glass.

When the barrier film is directly formed on the alkali-containing glass plate, the alkali ingredient contained in the glass affects the compactness of the barrier film formed thereon, thus affecting the efficiency of preventing diffusion of metal ions.

That is, when the diffusion barrier film is formed by a physical

vapour deposition method such as a sputtering method, an ion plating method, or a vacuum evaporation method, alkali is diffused in a trace amount from the glass during the film formation and the diffusion of alkali may affect~~s~~ the crystal structure of the barrier film. In case of a large amount of diffused alkali, the crystal structure of the barrier film is deteriorated so that the barrier film becomes porous, thus decreasing the efficiency of preventing the diffusion of metal ions.

When the barrier film for preventing diffusion of metal ions is formed by an application method such as a printing method or a sol/gel method, the application process should be followed by a baking or firing process. The above crystal structure of the barrier film may be deteriorated during the baking or firning process after the application of diffusion barrier material.

When the barrier film is formed by a chemical vapour deposition (CVD) method such as a chemical gaseous phase deposition method, the same phenomenon as the case of using the physical vapour deposition method occurs ~~is occurred~~. When the barrier film is formed by the CVD method, source material used in the method generally contains chlorine so that the material liberates the chlorine during the film formation and the chlorine reacts with alkali ingredient contained in the glass substrate so

as to deposit chlorine compounds on the glass substrate. Portions where the chlorine compounds are formed do not allow the formation of the above barrier film mainly consisting of indium oxide and/or tin oxide so that the barrier film has pin holes. The diffusion of metal ions can not be prevented at such portions.

Accordingly, in order to remove the affection due to alkali contained in the glass substrate, an under layer for preventing diffusion of alkali ions (hereinafter, sometimes referred to just as "under layer") is previously formed on the alkali-containing glass substrate. The barrier film mainly consisting of indium oxide and/or tin oxide is formed on the under layer, thereby exhibiting the effect of securely preventing the diffusion of metal ions.

In the glass article of the present invention, an insulating film is formed on the barrier film, if necessary, and an electrode film, preferably including Ag , is further formed on the insulating film.

The surface electrical resistance of the insulating film is preferably in a range from $1.0 \times 10^6\ \Omega/\square$ to $1.0 \times 10^{16}\ \Omega/\square$. The surface electrical resistance of the insulating film is preferably kept in the range from $1.0 \times 10^6\ \Omega/\square$ to $1.0 \times 10^{16}\ \Omega/\square$ even after heating process at 550 °C for 1 hour, i.e. the heating conditions of usual manufacturing process

R'O 6-27 mass %

R_2O is the sum of Li_2O, Na_2O, and K_2O, and R'O is the sum of CaO, MgO, SrO, and BaO.

The barrier film 2 mainly consist~~ing~~s of In_2O_3 and/or SnO_2.

A film mainly consisting of In_2O_3 or SnO_2 is generally used as a transparent conductive film. In particular, an In_2O_3 film containing 5 mass % Sn (ITO) and a SnO_2 film in which fluorine or antimony is doped are preferably used because of their low surface electrical resistance. According to the present invention, there is no special limitation on impurity concentration in the barrier film 2 because the diffusion of metal ions can be prevented regardless of the value of surface electrical resistance. However, when the barrier film 2 is used also as an electrode, the aforementioned composition having low surface electrical resistance is preferably used as the barrier film 2. In case of application necessitating high surface electrical resistance such as a rear window glass of an automobile and a substrate for a display, the insulating film 3 is preferably formed on the barrier film 2 mainly consisting of In_2O_3 and/or SnO_2 as shown in Fig. 2.

The barrier film 2 does not have special limitation on the ratio between In_2O_3 content and SnO_2 content.

formed in the same manner as Example 1. The degree of stain was observed and the result is shown in Table 1.

Comparative Example 4

A barrier film of SiO_2 having a thickness shown in Table 1 was formed by a CVD method in the same manner as Example 6, but using monosilane instead of the MBTC and using ethylene instead of the water vapor. After that, an Ag electrode was formed in the same manner as Example 1. The degree of stain was observed and the result is shown in Table 1.

Examples 7-11

Each under layer shown in Table 1 was formed prior to the formation of a barrier film on a soda lime glass substrate as formed in Examples 1, 2, 3, and 6.

As for Examples 7-10, the under layer was formed to have a thickness of 20 nm by the sputtering method using an oxide target and in RF mode. As for Example 11, the under layer was formed to have a thickness of 20 nm by the CVD method just like Comparative Example 4.

As for Example 7, a barrier film was formed in the same manner as Example 1 after forming the under layer of SiO_2.